CLAIMS:

1. A mass spectrometer based on the use of quadrupole lenses with angular gradient of the electrostatic field comprising:

an ion source with an ion outlet for emission of ions of a substance to be analyzed;

an ion mass separation chamber sealingly connected to said ion source and receiving said ions from said ion source, said ion mass separation chamber having electrostatic field generation means for generating a helical electrostatic field that defines helical trajectories of ions in the direction of their propagation, each of said helical trajectories consisting of a direct section in the direction of propagation from said ion source to a point of reverse and a reverse section from said point of reverse towards said ion source, said electrostatic field generation means having a longitudinal axis oriented in said direction of propagation;

electrostatic mirror means for reducing scattering of positions of said points of return, said electrostatic mirror means being located at the end of said direct part;

an ion-electron emitting screen located on the path of said ions in said reverse section; and

an ion detector located at the end of said reverse section and having ion detecting means for detecting positions of collision of said ions with said ion-electron emitting screen over time and space.

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2. The mass spectrometer of Claim 1, wherein said outlet of said ion source is offset with respect to said longitudinal axis of said electrostatic field generation means.

3. The mass spectrometer of Claim 2, wherein said electrostatic field generation means comprises a plurality of quadrupole electrostatic lenses which are arranged in series in said direction of propagation and form a

central ion-guiding channel for propagation of said ions, each of said quadrupole electrostatic lenses comprising a circular body formed by four arch-shaped poles located substantially in a common plane perpendicular to said longitudinal axis and arranged circumferentially about said longitudinal axis in the form of a first pair composed of two diametrically opposite and electrically connected poles and a second pair composed of two diametrically opposite and electrically connected poles, in each of said quadrupole electrostatic lenses said poles being angularly shifted with respect to said poles of a subsequent quadrupole electrostatic lense by a selected angle.

4. The mass spectrometer of Claim 3, wherein said selected angle is equal to 360° divided by the number of quadrupole electrostatic lenses in said plurality.

5. The mass spectrometer of Claim 3, further comprising: a first power source having a negative terminal, a positive terminal, and a midpoint between said negative terminal and said positive terminal; and a second power source having a negative terminal and a positive terminal; said first pair of two diametrically opposite poles being connected to said positive terminal of said first power source via a first resistor, said second pair of two diametrically opposite poles being connected to said negative terminal of said first power source, said midpoint of said first power source being connected to said negative terminal of said second power source via a second resistor, said positive terminal of said second power source being grounded, said second power source generating a current of a high voltage which is higher than voltage of said first power source; said high voltage decreasing from one quadrupole electrostatic lenses to another quadrupole electrostatic lenses in said direction of propagation.

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6. The mass spectrometer of Claim 1, wherein in said direct section radii of said helical trajectory gradually increase, and on said reverse section radii of said helical trajectory gradually decrease.

7. The mass spectrometer of Claim 5, wherein in said direct section radii of said helical trajectory gradually increase, and on said reverse section radii of said helical trajectory gradually decrease.

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8. The mass spectrometer of Claim 5, wherein each said quadrupole electrostatic lens is assembled from a first disk member and a second disk member which are identical, electrically isolated from each other, and are assembled in mirror positions with respect to each other, said first disk member having said first pair of two diametrically opposite poles, said second disk member having said second pair of two diametrically opposite poles, said first pair of diametrically opposite poles being angularly shifted with respect to said second pair of diametrically opposite poles by 90°.

9. The mass spectrometer of Claim 8, wherein said first disk member has at least one pocket for accommodation of said first resistor, and wherein said second disk member has at least one pocket for accommodation of said second resistor.

10. The mass spectrometer of Claim 1, wherein said ion detector comprises at least one micro-channel plate.

11. The mass spectrometer of Claim 10, wherein said ion detector is provided with position adjustment means for adjusting position of said detector in match conditions of the most optimum performance.

12. The mass spectrometer of Claim 3, wherein said ion detector comprises at least one micro-channel plate.

13. The mass spectrometer of Claim 12, wherein said ion detector is provided with position adjustment means for adjusting position of said detector in matched conditions of the most optimum performance.

14. The mass spectrometer of Claim 8, wherein said ion detector comprises at least one micro-channel plate.

15. The mass spectrometer of Claim 14, wherein said ion detector is provided with position adjustment means for adjusting position of said detector in match conditions of the most optimum performance.

16. The mass spectrometer of Claim 1, wherein said electrostatic mirror means comprise at least one electrostatic mirror coaxial with said quadrupole electrostatic lenses and located after the last quadrupole electrostatic lens in said ion propagation direction.

17. The mass spectrometer of Claim 16, wherein said at least one electrostatic mirror comprises a continuous ring with a positive potential applied from a first powder source, said at least one electrostatic mirror being provided with a potential adjustment means.

18. The mass spectrometer of Claim 3, wherein said electrostatic mirror means comprise at least one electrostatic mirror coaxial with said quadrupole electrostatic lenses and located after the last quadrupole electrostatic lens in said ion propagation direction.

19. The mass spectrometer of Claim 18, wherein said at least one electrostatic mirror comprises a continuous ring with a positive potential applied from a first powder source, said at least one electrostatic mirror being provided with a potential adjustment means.

20. The mass spectrometer of Claim 5, wherein said electrostatic mirror means comprise at least one electrostatic mirror coaxial with said quadrupole electrostatic lenses and located after the last quadrupole electrostatic lens in said ion propagation direction.

21. The mass spectrometer of Claim 20, wherein said at least one electrostatic mirror comprises a continuous ring with a positive potential applied from a first powder source, said at least one electrostatic mirror being provided with a potential adjustment means.

22. The mass spectrometer of Claim 8, wherein said electrostatic mirror means comprise at least one electrostatic mirror coaxial with said quadrupole electrostatic lenses and located after the last quadrupole electrostatic lens in said ion propagation direction.

23. The mass spectrometer of Claim 22, wherein said at least one electrostatic mirror comprises a continuous ring with a positive potential applied from a first powder source, said at least one electrostatic mirror being provided with a potential adjustment means.

24. The mass spectrometer of Claim 1, further comprising a magnetic mirror which is located at the end of said ion mass separation chamber and consists of a plurality of permanent magnets arranged circumferentially around said end of ion mass separation chamber and a permanent magnet at the end face of said ion mass separation chamber.

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25. The mass spectrometer of Claim 3, further comprising a magnetic mirror which is located at the end of said ion mass separation chamber and consists of a plurality of permanent magnets arranged circumferentially around said end of ion mass separation chamber and a permanent magnet at the end face of said ion mass separation chamber.

26. The mass spectrometer of Claim 8, further comprising a magnetic mirror which is located at the end of said ion mass separation chamber and consists of a plurality of permanent magnets arranged circumferentially around said end of ion mass separation chamber and a permanent magnet at the end face of said ion mass separation chamber.

27. The mass spectrometer of Claim 17, further comprising a magnetic mirror which is located at the end of said ion mass separation chamber and consists of a plurality of permanent magnets arranged circumferentially around said end of ion mass separation chamber and a permanent magnet at the end face of said ion mass separation chamber.

28. The mass spectrometer of Claim 19, further comprising a magnetic mirror which is located at the end of said ion mass separation chamber and consists of a plurality of permanent magnets arranged circumferentially around said end of ion mass separation chamber and a permanent magnet at the end face of said ion mass separation chamber.

29. The mass spectrometer of Claim 21, further comprising a magnetic mirror which is located at the end of said ion mass separation chamber and consists of a plurality of permanent magnets arranged circumferentially around said end of ion mass separation chamber and a permanent magnet at the end face of said ion mass separation chamber.

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30. The mass spectrometer of Claim 23, further comprising a magnetic mirror which is located at the end of said ion mass separation chamber and consists of a plurality of permanent magnets arranged circumferentially around said end of ion mass separation chamber and a permanent magnet at the end face of said ion mass separation chamber.

31. A method of spectrometric mass analysis comprising the steps of:

providing a mass spectrometer comprising: an ion source with an ion outlet; an ion mass separation chamber having a central channel for passage of ions and connected to said ion source for receiving said ions from said ion source; electrostatic field generation means for generating an electrostatic field in said mass separation chamber; an electrostatic mirror means at the end of said mass separation chamber in the direction of ion propagation from said ion source, an ion-electron emitting screen located between said ion mass separation chamber and said ion source; and detectors located between said mass separation chamber and said ion source;

injecting packets of ions from said ion source into said ion mass separation chamber non-coaxially with said passage;

generating an electrostatic magnetic field in said ion separation means for directing said ions along a predetermined non-linear trajectory with gradual deceleration of said ions till points of return;

reducing scattering said points of return;

returning said ions along non-linear trajectories different from said predetermined non-linear trajectories; and

analyzing said ions by detecting points and times of collision of said ions with said ion-electron emitting screen.

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32. The method of Claim 31, wherein said predetermined non-linear trajectory is a helical trajectory, said method further comprising the steps of

preventing scattering of said points of return by means of said an electrostatic mirror means.

33. A method of spectrometric mass analysis comprising the steps of:

providing a mass spectrometer with an ion source and an ion mass separation chamber;

injecting packets of ions from said ion source into said ion mass separation chamber in a direction of ion propagation and non-coaxially with respect to said ion mass separation chamber;

generating a helical electrostatic field with electric potential gradually decreasing in said direction of propagation;

directing said ions along helical trajectories by means of said helical electrostatic field;

decelerating said ions moving along said helical trajectories till points of reverse;

reversing said ions from said points of reverse for returning in the direction opposite to said direction of propagation and along helical trajectories different from said helical trajectories in said direction of propagation; and

detecting said ions by time of flight and by spatially scattering said ions by their masses.

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